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Utility of tissue expansion in pediatric phallic reconstruction: a 10-year experience

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Abstract *Objective:* Boys with complex penile anomalies often undergo multiple operations, leaving a paucity of unscarred skin for further reconstructive procedures. Our objective was to evaluate the ability of tissue expansion to provide local skin for successful phallic reconstruction.
Materials and methods: Eighty boys (mean age of 11.9 years) with hypospadias ($n = 42$) or epispadias ($n = 38$) formed the study cohort. All patients had undergone at least one failed reconstructive operation. Indications for tissue expansion included scarcity of penile skin with urethral stenosis, urethrocutaneous fistula, chordee, and/or residual defect. One or two expanders were placed under the skin of the penile shaft and removed at the time of reconstruction.
Results: Average time between expander placement and reconstruction was 10.9 weeks. Mean follow-up time was 25.3 months. Complications during expansion occurred in 33 patients (41.3%). Twenty-two patients (27.5%) had at least one expander removed prematurely and 46.9% were replaced. Expansion yielded adequate tissue for reconstruction in 76 patients (95.0%). Successful outcomes were achieved in 39 patients after initial reconstruction and 25 patients after further intervention, yielding an overall success rate of 80.0%.
Conclusion: Tissue expansion is a useful tool with an acceptable rate of complications for phallic reconstruction in patients who have failed prior surgical reconstruction.

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Introduction

Reconstructive surgery for congenital penile defects, notably hypospadias and epispadias, is a common and evolving aspect of pediatric urology and plastic surgery. The principal goals of reconstruction include correction of penile chordee, advancement of the urethral meatus to the tip of the glans, restoration of normal urination, and provision of a functional and normal-appearing penis [1,2]. There are more than 300 techniques described for hypospadias correction, many involving multistaged algorithms, owing to the high rate of complication or failure to achieve optimal outcomes [3]. Complications associated with penile reconstruction include urethrocutaneous fistulae, urethral stenosis, penile scarring, persistence of chordee, and lack of skin and tissue for further reconstruction [4–6]. Urethral fistula is the most frequent complication, with an incidence of 5–44%, and an incidence of 60% in the initial postoperative period [7].

Concomitant with the development of complications is the need for recruitment of well-vascularized, supple tissue for secondary or tertiary reconstruction. Newer techniques for the reconstruction of the penis in the exstrophy/epispadias complex have been associated with glans and corporal loss, which can further increase the complexity of the reconstruction. Current solutions for skin coverage and urethroplasty include buccal mucosa, bladder mucosa, and/or full thickness skin grafts; acellular dermal matrix; and random local skin flaps [5]. The disadvantages of using extragenital skin or synthetic matrices include pigmentation mismatch, hair-bearing donor site, lack of sensation, questionable longevity of engineered constructs, and the propensity for complications when flaps are used. The use of expanded local genital tissue avoids these drawbacks by providing an abundance of well-vascularized skin for coverage, and the capsule of the expander adds an additional layer for coverage of the neourethra [8–12]. Furthermore, genital skin possesses similar amounts of androgen receptors, allowing the site to grow uniformly with adjacent tissue as the patient ages.

There are few reports in the literature regarding the use of tissue expansion in phallic reconstruction. Vordermark [8], Pascual et al. [9], and Mir et al. [10] reported good results with the use of tissue expansion in small cohorts of patients with hypospadias. Two larger studies involving 18 and 16 patients showed 47% and 81% success rates, respectively [11,12]. In this study, we report the largest clinical experience using tissue expansion for penile reconstruction in patients with congenital penile anomalies.

Methods

This study was approved by the Johns Hopkins Institutional Review Board.

We reviewed 80 consecutive patients who had undergone tissue expansion after having presented with multiple failed penile reconstructive procedures primarily for hypospadias or epispadias. Indications for tissue expansion included recurrent urethral stenoses, urethrocutaneous fistulae, residual hypospadias or epispadias, and chordee following previous reconstructive surgeries. On clinical examination, all 80 patients had a lack of tissue for reconstruction, defined as a scarcity of penile skin either to cover the defects from previous surgeries or to reconstruct the urethra after previously failed attempts. Some patients had received preoperative injections of testosterone enanthate in an attempt to obtain more penile skin, though tissue expansion was still required to generate sufficient skin for reconstruction in all cases. Among patients with a known surgical history, the average number of prior operations was 2.3. The mean age at the time of tissue expander implantation was 11.9 years (median 13.3, range 0.8–42.1).

The cohort included 42 patients with hypospadias and 38 with epispadias. Secondary diagnoses included 35 with bladder exstrophy, 20 with ambiguous genitalia, and one each with Prader–Willi, Y-chromosome microdeletion, and Smith–Lemly–Opitz. Within the hypospadias group, three patients had a urethral opening near the glans of the penis (coronal hypospadias), eight along the shaft (midshaft hypospadias), 16 near the junction of the penis and scrotum (penoscrotal or scrotal hypospadias), 13 in the perineum (perineal hypospadias), and two were unknown.

Tissue expander placement was based on the location of the desired tissue, as well as the malleability of the tissue. While supple, unscarred penile skin is preferred for expansion, some patients only had scarred tissue available for reconstruction. All patients received preoperative antibiotics (first-generation cephalosporin or clindamycin if allergic to penicillin). An incision was made through the penile skin and a subcutaneous pocket was created in the loose areolar tissue near the expected area of reconstruction (Fig. 1). Early in the series, the incision(s) was placed at the base of the penis, but we have since moved the incision to the junction between the shaft and glans. This has reduced our rate of infection and extrusion as it is easier to keep the site clean after surgery. A subcutaneous pocket between the skin and Dartos fascia was dissected and sized for subsequent expander insertion. Tissue expanders used were either 1.5 × 3.0 cm or customized size of 0.5 × 1.0 cm (PMT, Chanhassen, MN, USA). Fill volume for both expanders was 10 cm^3. During the initial experience, the number of tissue expanders implanted was based on the amount of skin required for reconstruction. All patients now have two expanders placed regardless of reconstructive needs. If one of the expanders becomes infected or extrudes and needs to be removed, the remaining expander frequently provides enough tissue to complete the reconstruction. Overall, 18 patients (22.5%) had a single tissue expander placed and 62 (77.5%) had two tissue expanders placed. Surgery for placement of the tissue expanders typically takes 60–75 min. The children are allowed to void normally after surgery and no urinary catheter is placed. For children in a diaper, the parents were asked to clean the incision sites with soap and water after each bowel movement for the first week.

The expanders were usually implanted laterally, but positioned dorsally or ventrally as needed based on urethral location. Using a separate incision, another subcutaneous pocket was dissected above the pubic bone region for placement of the buried expander port. A subcutaneous tunnel was created between the port and the expander for tubing placement. Incisions were closed with buried absorbable sutures.

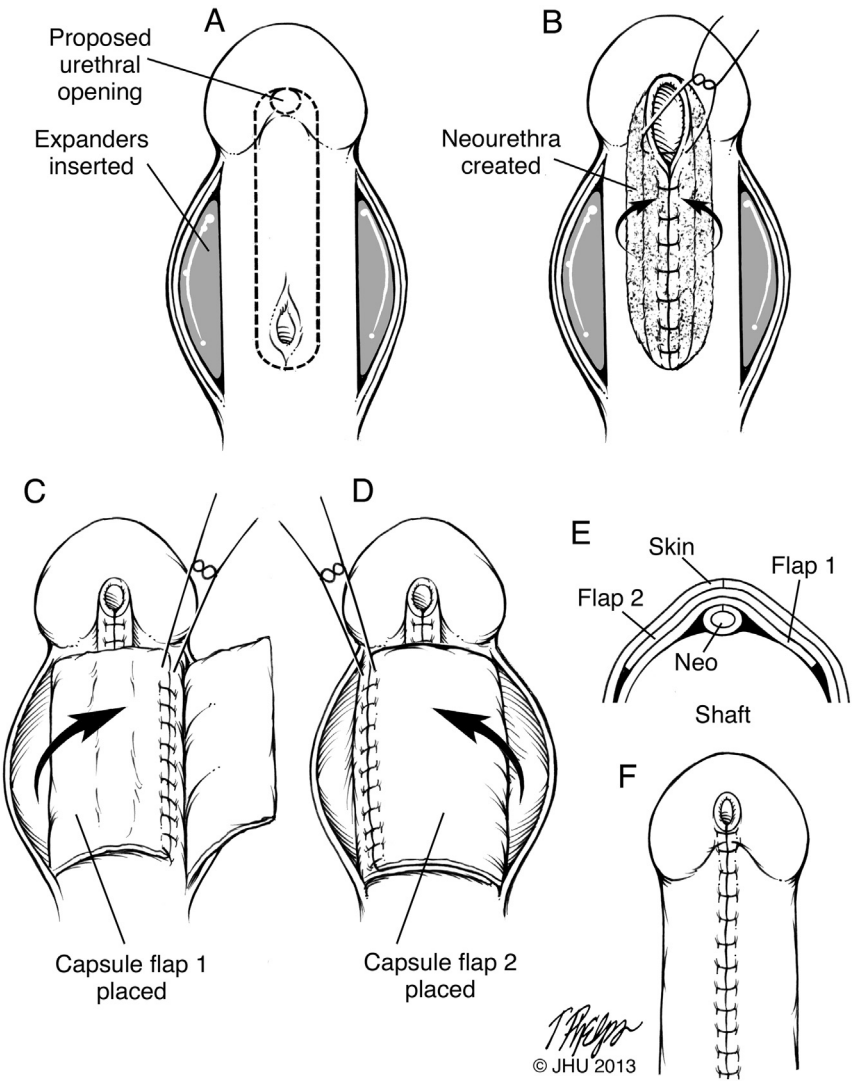

Figure 1 Illustration of tissue expansion-assisted urethral reconstruction. Tissue expanders were inserted under the skin of the penile shaft (A). The neourethra was created with use of the residual urethral plate and neighboring shaft skin and covered with a one- or two-layered vascularized fibrous capsule, which develops around the tissue expanders (B—D). The procedure yields a reconstructed phallus with the urethral meatus at the tip of the glans (E, F).

Weekly saline injections were performed starting 2 weeks after surgery and continued until adequate tissue expansion had been achieved, which was typically 6—7 weeks. Weekly injections were 1—3 cm^3 into each expander. The expanders were removed at the time of urethral reconstruction. The expanded, nonhair-bearing shaft skin was used for urethral reconstruction and penile skin coverage, and the capsule that developed around the expander was used as a secondary vascularized layer for protection of the neourethra.

Results

Among the 80 patients who underwent placement of tissue expanders, complications during the period of tissue expansion occurred in 33 patients (41.3%). Expanders became infected ± extrusion in 10 patients (11 expanders), with two patients managed conservatively (e.g., antibiotics only, incision, and drainage) and eight patients (nine expanders) by expander removal. Expander leak ± extrusion occurred in eight patients (nine expanders) and required expander removal in two patients (three expanders). Eighteen patients (24 expanders) had isolated expander extrusion managed with re-closure in two patients and expander removal in 13 patients (19 expanders). One patient developed a hematoma that was managed by operative washout, and three patients had expander migration requiring removal in one case. Among the 32 expanders removed, 11 were replaced at the time of removal, and four were replaced at an average of 4.9 months (range 3.0—9.8). Overall, 22 patients (27.5%) had at least one expander removed with or without expander replacement.

Tissue expansion provided sufficient skin for reconstruction in 76 patients (95.0%). The mean time between expander placement and reconstruction was 10.9 weeks (median 8.4, range 4.0—55.7) with a mean follow-up time of 25.3 months (median 13.1, range 0.1—189.0). Surgical

success was defined as advancement of the urethra to or near the tip of the glans without residual urethrocutaneous fistula, urethral strictures or stenosis, chordee, or wound-healing problems at last follow-up. Overall, 39 patients had a successful outcome after one round of expansion and reconstruction with no additional operations. Fistulae developed in 22 patients (five observed, 17 managed surgically), urethral stricture or stenosis in 14 patients (all managed surgically), chordee in nine patients (all managed surgically), and skin breakdown in four patients (two observed, two managed surgically). Four patients underwent 1—2 additional rounds of tissue expansion to generate sufficient tissue to complete their final reconstruction. Among patients with postoperative complications, 25 had a successful outcome after an average of 2.2 additional reparative and/or reconstructive procedures. Thus, a total of 64 of 80 patients ultimately achieved a successful result, yielding an overall success rate of 80.0%.

Patients with an underlying diagnosis of exstrophy/epispadias had a success rate of 82.9% (29/35) after initial tissue expansion and reconstruction, and an overall success rate of 94.3% (33/35). For non-exstrophy patients, the initial success rate was 22.2% (10/45) and overall success rate was 68.9% (31/45). Complications during tissue expansion occurred with 28.6% (10/35) of exstrophy/epispadias patients and 51.1% (23/45) of non-exstrophy patients. The average number of prior surgical repairs was 1.9 for exstrophy/epispadias patients and 2.5 for non-exstrophy patients.

Of the patients who did not achieve a successful surgical outcome, four never completed reconstruction and 12 had unsuccessful outcomes at the time of last follow-up. Reconstruction was delayed for four patients owing to persistent expander extrusion and removal. Among the patients with unsuccessful outcomes, five had a residual fistula, one had a recurrent stricture, and two had wound-healing problems, including scarring and skin breakdown. The urethra was located at a site other than at or near the tip of the glans in four patients. At last follow-up, seven (58.3%) of the patients with unsuccessful outcomes were awaiting additional reconstructive surgery. Outcomes for tissue expansion and reconstruction are shown in Fig. 2.

Discussion

Problems such as urethrocutaneous fistulae, urethral stenosis or strictures, and residual chordee may complicate initial phallic reconstruction. Secondary procedures to correct these complications are challenging, particularly in patients in whom multiple operations have resulted in diffuse scarring and shortage of local tissues. Therefore, extragenital skin, bladder mucosa, and buccal mucosa have been used as free grafts for creation of the neourethra and to provide needed soft tissue coverage. Each of these tissues is associated with specific problems and long-term complications. Extragenital skin, even if taken from a nonhair-bearing location in a child, can eventually form hair in the urethra and lead to stone formation and/or irritation. Bladder mucosa hypertrophies and desiccates quickly when exposed to air, which may lead to eventual stenosis, the most common complication of using this tissue in urethroplasty [5,12]. Reports of using buccal mucosa are encouraging; however, overall, the rate of complications such as recurrent stenosis or stricture and fistula formation may be as high as 44% [7].

Tissue expansion is not a new plastic surgery concept, and pregnancy is considered a physiological model of this

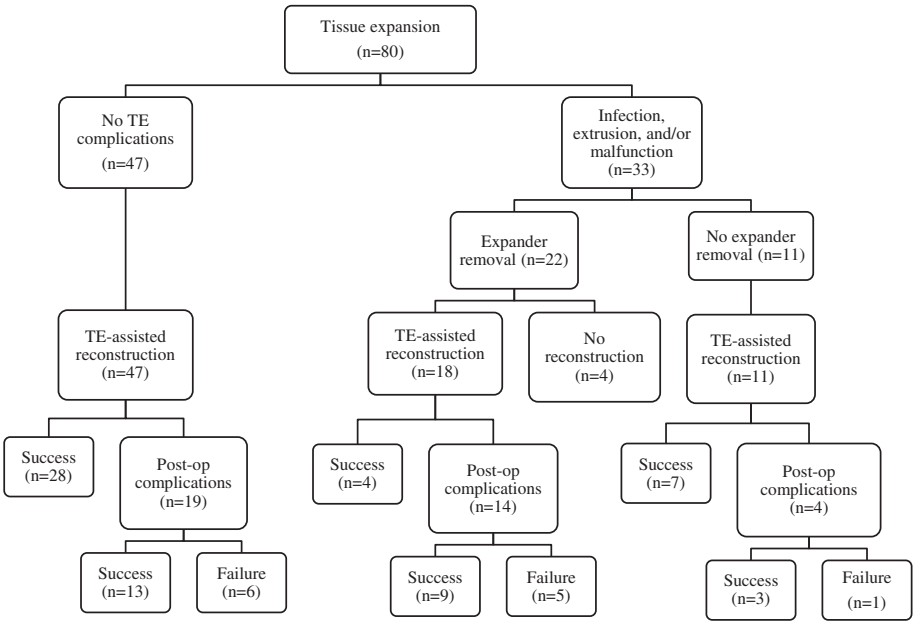

Figure 2 Outcomes for tissue expansion and reconstruction. *Note*. TE = tissue expansion.

process. Tissue expanders have been used extensively for many procedures when there is a paucity of supple local tissues. Previous reports of the use of tissue expanders in phallic reconstruction have shown promising results when the expanded skin is used for skin coverage [11,12]. This method provides additional local tissue of optimal pigment and texture match for penile reconstruction, as well as preservation of sensation. Most notably, tissue expansion provides additional skin with a similar androgen receptor density as inner prepuce, urethra (corpus spongiosum), and stromal cells of the corpora cavernosa [13].

To our knowledge, this is the largest clinical series of penile reconstruction using tissue expansion for provision of skin for reconstruction. The goals of treatment for patients with multiple failed phallic repairs are similar to those of primary reconstruction, namely to correct chordee, fistulae, and urethral stenosis or strictures; bring the meatus to or near the tip of the glans; create a functioning neourethra; and facilitate normal voiding with good penile appearance. Overall 80.0% (64/80) of our patients who underwent tissue expansion met these goals. When considering outcomes only among patients who completed reconstruction, 84.2% (64/76) of our patients had a successful surgical result. This represents a substantial improvement in outcomes compared with those reported in our prior institutional study by Mathews et al. [11], which found an overall success rate of 50.0% (9/18) among patients who received tissue expansion, and 53.0% (9/17) among patients who ultimately underwent reconstruction. The increase in successful surgical results likely reflects improved surgical technique stemming from greater experience with tissue expansion-assisted reconstruction.

The markedly increased success rate among exstrophy/epispadias patients is a finding unique to our study. Mathews et al. [11] found an insignificant difference in the rate of overall successful outcomes between exstrophy/epispadias patients (67% successful) compared with hypospadias patients (57% successful), where males with exstrophy/epispadias comprised 52.9% (9/17) of patients [11]. In contrast, with a similar comparison among patients who underwent reconstruction (34 exstrophy/epispadias, 42 non-exstrophy), our study shows that the rate of overall surgical success was much higher for exstrophy/epispadias patients (97.0% successful) compared with non-exstrophy patients (73.8% successful), where boys with exstrophy/epispadias comprised 44.7% (34/76) of patients. Though bladder exstrophy patients undergo numerous staged abdominal procedures, they had fewer penile reconstructive procedures compared to non-exstrophy patients with hypospadias or epispadias (1.9 vs 2.5). This disparity may underlie the unequal success rates, as more penile operations lead to increased local scarring and scarcity of tissue that complicates subsequent reconstructive efforts. Notably, the smaller proportion of exstrophy/epispadias patients in our study compared with Mathews et al. [11] further supports the reasoning that improvements in surgical technique, rather than treatment of more exstrophy/epispadias patients, is the driver of increased surgical success over time.

Though a successful surgical result was ultimately achieved for the majority of patients, secondary phallic reconstruction remains a difficult undertaking, largely owing to extensive scarring. Patients with successful outcomes after penile reconstruction and/or repair beyond initial expansion and reconstruction required an average of 2.2 additional procedures, demonstrating the difficulty associated with continued reconstructive efforts. However, cases requiring more than one operation after initial tissue expansion-based reconstruction should not be considered failures of expansion techniques. On the contrary, tissue expansion can be considered the first stage in long-term phallic rehabilitation that enables reconstruction from local tissue and thus provides significant aesthetic and functional benefits.

Conclusions

Tissue expansion is another technique in the armamentarium of the plastic surgeon to provide supple local skin for penile reconstruction in the patient that has failed prior surgery. Patients presenting with significant scarring of the penis should be counseled regarding the difficulties associated with reconstruction and the expectation that tissue expansion is only one step in the process of rehabilitating the significantly scarred phallus. Secondary phallic reconstruction in conjunction with tissue expansion has demonstrated an acceptable rate of success, and we expect outcomes to continue to improve as tissue expansion is increasingly employed as an assistive technique.

Conflict of interest

None.

Funding sources

None.

References

[1] Santanelli F, D'Andrea F, Savanelli A, Molena G, Scuderi N. Reconstruction of hypospadias with a vertical preputial island flap. A follow-up study of 127 patients. Scand J Plast Reconstr Surg Hand Surg 1990;24:67—73.
[2] Arap S, Mitre IA. Penoscrotal hypospadias. Braz J Urol 2000;26:304—14.
[3] Baskin LS, Ebbers MB. Hypospadias: anatomy, etiology, and technique. J Pediatr Surg 2006;41:463—72.
[4] Hayashi Y, Kojima Y. Current concepts in hypospadias surgery. Int J Urol 2008;15:651—64.
[5] Elbakry A. Management of urethrocutaneous fistula after hypospadias repair: 10 years' experience. BJU Int 2001;88:590—5.
[6] Samuel M, Capps S, Worthy A. Distal hypospadias: which repair? BJU Int 2002;90:88—91.
[7] Wood HM, Kay R, Angermeier KW, Ross JH. Timing of the presentation of urethrocutaneous fistulas after hypospadias repair in pediatric patients. J Urol 2008;180(Suppl. 4):1753—6.
[8] Vordermark JS. Tissue expansion for urethral and penile reconstruction. Dialogues Pediatr Urol 1995;18:4.
[9] Pascual LA, Benegas JC, Cuevas CR, Vega Perugorria JM. Tissue expander enhanced onlay island flap in the repair of severe hypospadias. J Urol 2003;169:606.

[10] Mir T, Simpson RL, Hanna MK. The use of tissue expanders for resurfacing the penis for hypospadias cripples. Urology 2011; 78:1424—9.
[11] Mathews R, Nelson CP, Gearhart JP, Vander Kolk CA. Tissue expansion in management of failed phallic reconstruction: initial report of clinical series. Urology 2005;66:180—4.
[12] Kajbafzadeh AM, Sina A, Payabvash S. Management of multiple failed repairs of the phallus using tissue expanders: long-term postpubertal results. J Urol 2007;177:1872—7.
[13] Celayir S, Eliçevik M, Tireli G, Dervisoğlu S, Sander S. Expression of androgen receptors in children with hypospadias: preliminary report. Arch Androl 2007;53:83—5.